EFFECTS OF SUMMER HEAT STRESS ON GROWTH PERFORMANCE, SOME CARCASS TRAITS AND BLOOD COMPONENTS OF NEW ZEALAND WHITE RABBITS FED DIFFERENT DIETARY PROTEIN-ENERGY LEVELS, UNDER SUBTROPICAL EGYPTAIN CONDITIONS

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Abstract - Eighty male New Zealand White rabbit weanlings, were used in this study. Animals fed normal protein-normal energy level (NP-NE) diet showed reduction in summer than in winter in body weight (14.2%), daily gain weight (20.3%), feed intake (22.9%), feed cost (22.9%), return from body gain (20.4%) and final margin (18.5%). Carcass, most of carcass cuts, kidney fat and liver weights were also lower in summer than in winter. Similarly, concentrations of each total protein, albumin, urea-N, creatinine (as kidney function) and serum transaminase enzymes (as liver function) decreased under summer conditions.
Within each of the two seasons, rabbits fed high protein-normal energy (HP-NE) diet recorded higher body weight, gain weight, feed efficiency and final margin, while feed intake was lower when compared with the other groups. Kidney fat weight recorded higher values in rabbits fed high protein-high energy (HP-HE) diet than in those fed normal protein-normal energy (NP-NE), while carcass and carcass cuts weights were not consistently influenced by protein-energy level in rabbit diets. Concentrations of the studied blood components were higher in rabbits fed HP-NE diet than in those fed NP-NE diet.
Comparison of summer groups (NP-HE, HP-NE and HP-HE) with NP-NE winter group, showed that rabbits fed HP-NE summer group recorded the highest body weight, daily gain weight and final margin and the lowest feed intake and feed cost, carcass, most of carcass cuts weight, total protein and its fractions and transaminase enzymes.
The effects of season and ration type on body, gain, carcass, kidney fat and fore part weights and serum protein, albumin, transaminase enzymes, creatinine and urea-N concentrations were significant ($P<0.01$). The estimated interactions between season and ration type on the growth traits were not significant, except on body weight at four weeks and on gain weight at 0-4 weeks of the experimental period which were significant ($P<0.05$).

INTRODUCTION

Under normal conditions, NRC (1977) estimated the nutrient requirements of rabbits fed *ad libitum* with 16% crude protein, 2500 kcal digestible energy and 10-12% crude fibre, while under tropical conditions RICO and MENCLACA (1973) reported that 14% crude protein would meet the needs of growing rabbits. However, LEBAS (1973) and CHEEKE (1987) indicated that 17-18% and 18%, respectively, crude protein were optimal levels under tropical conditions. Simultaneously, the information about the protein-energy levels suitable to growing rabbits under subtropical hot climates, are lacking.
The present investigation aimed to study effects of different dietary protein-energy levels on growth performance, some carcass traits and blood components of New Zealand White rabbits, under the subtropical hot climate conditions of Egypt.

MATERIALS AND METHODS

The study was conducted in the Rabbitry Farm of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, using eighty weanling male New Zealand White rabbits of 35 days of age, with nearly equal live body weights at beginning of the experiment. The rabbits were allotted to eight treatment groups of 10 rabbits each. The rabbits of four groups were reared in winter (air temperature 19.7 °C and relative humidity 78.4%) and the other four in summer season (air temperature 32.9 °C and relative humidity 69.4%). Within each season, the groups were fed normal protein-normal energy diet (NP-NE as control group), normal protein-high energy diet (NP-HE), high protein-normal energy diet (HP-NE) and high protein-high energy diet (HP-HE). The composition and chemical analysis of the experimental diets are as shown in Table 1.

Table 1 : Ingredients percentages and chemical analysis of the experimental diets used in either winter or summer

Items	NP-NE	NP-HE	HP-NE	HP-HE
Ingredients (%):				
Alfalfa hay	23.0	28.0	22.0	30.0
Corn	14.0	28.0	10.0	24.0
Soybean meal	10.0	13.0	15.0	19.0
Wheat bran	48.0	26.0	48.0	22.0
Molasses	3.0	3.0	3.0	3.0
Limestone	1.4	1.4	1.4	1.4
Sodium chloride salt	0.3	0.3	0.3	0.3
Vitamin and mineral premix	0.3	0.3	0.3	0.3
Chemical composition:				
Crude protein (%)	16.10	16.05	18.17	18.15
Digestible protein (%)*	13.4	13.3	15.1	15.2
Crude fibre (%)	12.67	12.36	12.55	12.39
Digestible energy (kcal/kg)*	2568.0	2732.0	2588.0	2734.0
Digestible energy (Mj/kg)*	10.75	11.44	10.83	11.44

* Calculated according to NRC (1977), NP = Normal protein, HP = High protein, NE = Normal energy, HE = High energy.

All animals were kept under the same managerial and hygienic conditions and were housed in batteries provided with feeders and clean fresh water, all time. The rabbits were weighed and feed consumption was estimated at weekly intervals. At the end of the experimental period (8 weeks), 5 rabbits from each group were randomly taken for slaughter after being fasted for 12 hours. After complete bleeding, the carcass and some non carcass components, were weighed. Blood samples were taken at the time of slaughter to estimate blood components. Only one rabbit died in the group fed NP-HE, during winter season.

The data of body and gain weights and blood components were statistically analyzed by 2 x 4 factorial experiment using the following model according to SNEDECOR and COCHRAN (1982):

$$Y_{ijk} = \mu + S_i + R_j + SR_{ij} + e_{ijk} \qquad (1)$$

where, μ = the overall mean, S_i = the fixed effect of th season, winter and summer (i = 1, ..2), R_j = the fixed effect of j^{th} dietary protein-energy levels (j = 1, ...4), SP_{ij} = the interaction between the i^{th} season and j^{th} dietary protein-energy levels and e_{ijk} = random error.

The data of slaughter test was analyzed using the following model:

$$Y_{ijk} = \mu + S_i + R_j + SR_{ij} + b(X-x) + e_{ijk} \qquad (2)$$

where, μ, S_i, R_j, SR_{ij}, and e_{ijk} as mentioned in model 1, b = partial linear regression coefficients of Y_{ijkl} on slaughter weights, X = value of slaughter weights and x = overall average of slaughter weights.

RESULTS

Temperature-humidity index

The temperature humidity index values calculated according to Livestock and Poultry Heat Stress Indices, Agriculture Engineering Technology Guide, Clemson University, SC 29634, USA, were 85.6 and 66.3 in summer and winter seasons, respectively, indicating that the experimental animals were exposed to severe heat stress in summer (between 84 to 86) and no stress in winter (less than 82).

Growth traits

Body weight and daily gain weight in animals fed NP-NE diet were lower in summer than in winter. Daily body gain/100 g live body weight was 1.79 and 2.00 g in the same seasons, respectively (Table 2).

Within each of the two seasons, rabbits fed HP-NE diet recorded higher body weight and gain weight when compared with the other groups (Table 2).

Comparison of summer groups (NP-HE, HP-NE and HP-HE) with NP-NE winter group showed that rabbits fed HP-NE recorded the highest body weight and gain weight (Table 2).

The effects of season and ration type on body weight and gain weight at most of periods studied were highly significant (P<0.001). The estimated interactions between season and ration type on growth traits were not significant, except on body weight at four weeks and on gain weight at 0-4 weeks of the experimental period which were significant (P<0.05; Table 3).

Feed efficiency

Feed intake of growing rabbits fed NP-NE diet was lower in summer than in winter (Table 2).
Within each of the two seasons of the year, feed intake was lower and feed efficiency was higher in the growing rabbits fed HP-HE diet than in those fed NP-NE diet (Table 2).
Comparison between the summer groups and NP-NE winter group showed that feed intake was the lowest, while feed efficiency was the highest in HP-NE and HP-HE summer groups (Table 2).

Profit analysis

Feed cost, return and final margin of NP-NE group were lower in summer than in winter due to the decrease in feed intake and body gain (Table 2).
Within each season of the year, rabbits fed HP-NE diet recorded higher return from body gain and final margin than in those fed NP-NE diet. However, feed cost was lower in HP-NE group during winter season (Table 2).
The summer HP-NE, NP-HE and HP-HE groups showed higher final margin and lower feed cost than in winter NP-NE group (Table 2).

Table 2 : Averages of body weight, gain weight and feed efficiency as affected with season of year and dietary protein-energy level in New Zealand White growing rabbits, under Egyptian conditions

Groups	Winter				Summer			
	NP-NE	NP-HE	HP-NE	HP-HE	NP-NE	NP-HE	HP-NE	HP-HE
Body weight at (Weeks) g:								
0	533.5±20.6	527.8±23.1	528.0±6.9	532.0±13.1	538.0±14.7	535.0±16.5	536.5±19.1	535.5±13.9
4	1228.0±24.1^{a}	1262.2±33.5^{a}	1275.0±23.7^{a}	1261.0±21.9^{a}	985.5±22.1^{a}	1148.5±56.1^{b}	1191.0±20.9^{b}	1207.0±28.7^{b}
8	1882.5±39.8	2003.3±52.8	2160.0±25.4	2105.0±64.4	1615.0±22.7	1772.0±30.2	1948.0±30.4	1845.0±83.8
Body gain weight (Weeks) g:								
4 - 0	24.8±0.9^{a}	26.2±1.4^{a}	26.7±0.8^{a}	26.0±1.0^{a}	16.0±0.8^{a}	21.9±1.7^{b}	23.4±0.8^{b}	24.0±1.1^{b}
4 - 8	23.4±0.9	26.5±1.4	31.6±1.1	30.1±1.9	22.5±0.9	22.3±1.3	27.0±1.0	22.8±2.5
0 - 8	24.1±0.7	26.4±0.8	29.1±0.4	28.1±1.2	19.2±0.3	22.1±0.5	25.2±0.6	23.4±1.4
Daily gain g/100 g body weight	2.00±0.05	2.08±0.04	2.17±0.02	2.12±0.05	1.79±0.03	1.92±0.04	2.03±0.05	1.95±0.05
Feed efficiency:								
Daily feed intake (g)	118.0	110.0	98.0	90.0	91.0	85.0	87.0	79.0
Feed conversion (g feed/g gain)	4.90	4.17	3.67	3.20	4.74	3.85	3.45	3.38
Feed efficiency (g gain/g feed)	0.204	0.240	0.297	0.312	0.211	0.26	0.290	0.296
Profit analysis:								
Feed cost (LE/head)	3.40	3.27	3.27	3.07	2.62	2.52	2.90	2.70
Return from body gain (LE/head)	8.10	8.87	9.78	9.44	6.45	7.43	8.47	7.86
Margin (LE/head)	4.70	5.60	6.51	6.37	3.83	4.91	5.57	5.16

Means bearing different latters within the same classification, differ significantly ($P<0.05$).
Prices: Rations (kg) NP-NE diet = 0.515 LE, NP-HE diet = 0.53 LE, HP-NE diet = 0.596 LE and HP-HE diet = 0.61 LE.
Rabbit live body weight = 6.0 L.E. per kg (One LE = 0.29 $).
* Margin per head = Return from body gain - Feed cost., other head costs are assumed constant.

Table 3 : Test of significance for the effects of season of year and ration type on body weight and gain weight in New Zealand White rabbits, under Egyptian conditions.

SOV	df	Means squares						
		Body weight (Weeks)			Gain weight (Weeks)			Gain / 100 g body weight
		0	4	8	0 - 4	4 - 8	0 - 8	weight
Season (S)	1	693.8	301137.1***	1162007.7***	421.9***	357.0***	388.9***	0.571***
Ration type (R)	3	71.9	72361.6***	341706.3***	96.8***	153.5***	111.0***	0.152***
S x R	3	26.9	34403.2*	3298.5*	43.4	35.0	0.9	0.004
Error	71	2685.4	9397.6	22793.4	11.7	21.3	6.6	0.016

* $P< 0.05$ and *** $P< 0.001$.

Slaughter traits

Carcass, most of the carcass cuts, kidney fat and liver weights in NP-NE groups were lower in summer than in winter (*Table* 4).
season of the year, kidney fat weight recorded higher values in rabbits fed HP-HE diet when compared with those fed NP-NE. Carcass and carcass cuts weights were not consistently influenced by protein-energy levels in rabbit diets (Table 4).

Table 4 : Least squares means for carcass traits as affected with season of the year and ration type in New Zealand White growing rabbits, under Egyptian conditions

Groups	Winter				Summer			
	NP-NE	NP-HE	HP-NE	HP-HE	NP-NE	NP-HE	HP-NE	HP-HE
Pre-slaughter body* weight (g)	1521.4±76.1	1487.2±45.3	1624.4±58.2	1556.8±64.4	1359.2±35.1	1492.0±77.7	1586.6±62.6	1442.6±61.2
Carcass weight (g)	871.8±8.3	882.2±8.3	906.6±8.6	894.6±8.3	855.2±8.8	833.7±8.3	855.3±8.5	855.3±8.4
Liver weight (g)	67.8±3.3	75.4±3.3	72.4±3.5	66.8±3.4	63.8±3.5	67.8±3.3	71.3±3.4	69.0±3.4
Kidney fat weight (g)	19.8±1.8	19.2±1.8	23.9±1.9	27.7±1.8	15.2±1.9	17.8±1.8	18.5±1.8	19.9±1.8
Head weight (g)	99.2±2.5	99.8±2.5	101.1±2.6	100.1±2.5	97.2±2.7	91.4±2.5	90.6±2.6	95.8±2.6
Fore part weight (g)	214.4±4.1	213.2±4.1	221.4±4.3	222.6±4.1	202.3±4.4	200.3±4.1	219.4±4.2	205.8±4.2
Intermediate part weight (g)	245.2±8.8	254.7±8.8	276.8±9.2	258.5±8.9	260.5±9.4	238.3±8.8	239.9±9.0	247.5±8.9
Hind part weight (g)	313.1±6.5	314.5±6.5	307.3±6.8	313.4±6.5	295.2±6.9	303.6±6.5	305.3±6.6	306.3±6.6
Dressing (%)	57.7	58.4	60.0	59.3	56.3	55.2	56.9	56.6

* Actual means.

Comparison between the experimental summer groups with NP-NE winter group showed that carcass and most of carcass cuts weights were the lowest in summer groups (Table 4).
Analysis of covariance showed that carcass, kidney fat, fore part (P<0.001) and hind part (P<0.05) and head weights (P<0.01) were significantly affected with the year season, while the effect of ration type was only significant on kidney fat weight (P<0.01), carcass weight and fore part weights (P<0.05). Regression of carcass and carcass cuts weights on pre-slaughter body weight were highly significant (P<0.001). The interaction between year season and ration type did not show any significant effect on carcass and non-carcass components (Table 5).

Table 5 : Analysis of covariance of the slaughter traits as affected with season of the year and ration type in New Zealand White growing rabbits, under Egyptian conditions

SOV	df	Means squares							
		Live body[1] weight	Carcass weight	Liver weight	Kidney fat weight	Head weight	Fore part weight	Intermediate weight	Hind part weight
Season (S)	1	59830.2	*** 14112.2	65.4	*** 215.3	** 367.5	*** 1117.9	1398.4	* 829.1
Ration type (R)	1	48315.2	* 1002.0	78.6	** 77.9	17.3	* 341.1	219.0	68.4
S x R	1	14058.6	595.5	43.2	17.4	35.3	99.3	1120.3	109.7
Regression on slaughter weight	*** 1	*** ---	298770.3	*** 1698.0	*** 1.3	*** 1064.4	*** 25242.7	24882.3	38948.3
Error	31	25889.3	344.2	55.4	15.9	31.9	86.9	388.5	211.2

* P< 0.05, ** P< 0.01 and *** P< 0.001, 1 Error df was 32 for live body weight.

Blood components

Concentrations of serum total protein, albumin, globulin, urea-N and creatinine (as kidney function) and transaminase enzymes (SGOT and SGPT as liver function) of NP-NE group were lower in summer than in winter (Table 6).

Within each season of the year, concentrations of the studied blood components were higher in rabbits fed HP-NE diet than in those fed NP-NE diet (Table 6).

Comparison between the experimental summer groups with NP-NE winter group showed that albumin, urea-N, creatinine and SGPT concentration were the highest in HP-NE summer group (Table 6).

Table 6 : Blood components as affected with season of year and ration type in New Zealand White rabbits, under Egyptain conditions.

Groups	Winter				Summer			
	NP-NE	NP-HE	HP-NE	HP-HE	NP-NE	NP-HE	HP-NE	HP-HE
Total protein (g/100 ml)	7.18±0.10	7.00±0.14	7.58±0.10	7.46±0.27	6.14±0.07	6.36±0.09	6.94±0.13	6.60±0.13
Albumin (g/100 ml)	3.48±0.12	3.80±0.11	4.16±0.13	4.10±0.18	2.90±0.07	3.24±0.12	3.86±0.05	3.34±0.09
Globulin (g/100 ml)	3.70±0.21	3.20±0.19	3.42±0.19	3.36±0.12	3.24±0.09	3.12±0.06	3.08±0.10	3.26±0.04
Urea-N (mg/100 ml)	16.12±0.52	16.08±0.92	17.94±0.78	18.76±0.33	13.60±0.63	15.38±0.83	16.64±0.89	16.68±1.16
Creatinine (mg/100 ml)	1.10±0.03	1.19±0.04	1.20±0.05	1.21±0.06	1.03±0.03	1.05±0.03	1.16±0.03	1.08±0.04
SGOT (U/100 ml)	28.54±0.62	28.60±0.94	29.44±0.77	29.88±0.95	24.30±0.99	24.66±1.18	26.10±2.07	28.16±0.70
SGPT (U/100 ml)	17.10±0.81	17.74±0.50	18.92±0.58	18.30±0.30	14.60±0.30	14.76±0.37	18.24±2.15	15.84±0.32

The year season showed significant effects on concentrations of serum total protein, albumin, creatinine, transaminase enzymes ($P<0.001$), urea-N ($P<0.01$) and globulin ($P<0.05$), and the ration type showed significant effects on total protein, albumin ($P<0.001$), urea-n ($P<0.01$), creatinine and SGPT ($P<0.05$). The interactions between season and ration type on blood components did not show any significant effect (Table 7).

Table 7 : Test of significance for blood components as affected with season of year and ration type in New Zealand White rabbits, under Egyptian conditions

SOV	df	Means squares						
		Total protein	Albumin	Globulin	Urea-N	Creatinine	SGOT	SGPT
Season (S)	*** 1	*** 6.320	* 3.025	** 0.600	*** 27.225	*** 0.094	*** 109.56	46.44
Ration type (R)	*** 3	*** 0.841	1.189	** 0.170	* 17.850	0.025	* 14.33	14.57
S x R	3	0.094	0.090	0.086	1.639	0.006	3.16	2.56
Error	32	0.094	0.067	0.096	3.142	0.007	6.22	3.92

* $P< 0.05$, ** $P< 0.01$ and *** $P< 0.001$.

DISCUSSION

In NP-NE groups, the severe heat stress conditions in summer, caused a reduction of 22.9% in daily feed intake, 14.2% in final body weight, 20.3% in daily gain weight and 18.5% in final margin than in winter. On the other hand, feed efficiency increased with 3.4% in summer than in winter (Figure 1). KASA *et al.* (1989) reported that the feed intake decreased by 12% at 30 °C than in those reared at 22 °C, and MARAI *et al.* (1994 a) observed a drop of 34.9% in feed intake and 19.4% in daily gain weight at 90 days of age when reared in summer season than those reared in winter. The severe heat stress conditions, slow down the metabolic pathways, causing drastic impairment of protein utilization due to shortage of hormones and enzymes, and a dramatic decrease in dry matter intake, apparent digestibility, volatile fatty acids production and electrolyte concentrations in the rumen fluids (NILES *et al.*, 1980). Weights of carcass, liver and kidney fat in the same group (NP-NE) were lower with 1.9, 5.9 and 23.2%, respectively, in summer than in winter season (Figure 2).

The study of blood components also showed that the concentrations of serum total protein, albumin and transaminase enzymes were lower in summer than in winter (Figure 3). The significant decline in serum protein with rising temperature seems to be due to depression of anabolic hormonal secretion such as growth hormone (YOUSEF and JOHNSON, 1966), in feed nitrogen and minerals intake and/or the increase in the catabolic hormones such as glucocorticoids and catecholamines (KAMAL, 1965). Generally, the plasma protein provides an efficient way of transferring the heat from inside the body to the outer surface of the skin for dissipation heat by non-evaporative processes during heat stress, since it holds adequate percentage of water in the intravascular fluids and maintains the viscosity of the blood (KAMAL *et al.*, 1962). The decrease in concentration of serum transaminase enzymes which lead to decrease protein biosynthesis may also be a reason in the adverse effects of the hot climate during summer season on growth performance of the New Zealand White rabbits. Similar results were obtained by SEQURA *et al.* (1979), NILES *et al.* (1980) and MARAI *et al.* (1994a and b). However, ABDEL-HAKEAM *et al.* (1991) found that the concentration of total protein and albumin were increased and McDOWELL *et al.* (1969) found that they were not affected with rising temperature. The concentrations of blood urea-N and creatinine (as kidney function) decreased in summer than in winter. The depression in blood urea-N may be due to the decrease in feed intake (EL-FOULY *et al.*, 1978 and YOUSEF, 1990). The increase in urinary nitrogen excretion under severe heat stress conditions as indicated by a negative nitrogen balance (KAMAL *et al.*, 1960) may also contribute to the decrease of serum urea level under such conditions.

Within seasons, rabbits fed HP-NE diet recorded higher final body weight, daily gain weight, feed efficiency, final margin, carcass weight and kidney fat weight with 14.7, 20.8, 45.6, 38.5, 4.0 and 20.7%, respectively, during winter and with 20.6, 31.3, 37.4, 45.4, 0.0 and 21.7%, respectively, during summer season, while feed intake decreased with 16.9 and 4.4% in winter and summer, respectively, than in those fed NP-NE diet (Figures 4 and 5). The HP-HE group recorded higher kidney fat weight with 39.9 and 30.9% in winter and summer seasons, respectively, when compared with NP-NE group (Figures 6 and 7). With regard to blood components, concentrations of serum total protein, albumin and transaminase enzymes were higher in rabbits fed HP-NE diet than in those fed NP-NE diet and rabbits fed HP-HE diet recorded lower serum protein and protein fractions than in those fed HP-NE within each the two year seasons (Figures 8 and 9). The latter results may be a response to the increase in heat stress due to the increase on heat produced through the high starch used as source of energy in the diet.

When comparison of summer groups (NP-HE, HP-NE and HP-HE) with NP-NE winter group, HP-NE summer group recorded higher final body weight, daily gain weight and final margin with 3.5, 5.8 and 18.5%, respectively. The increase in feed efficiency was 42.2% in the same group (Figure 10). HASSAN *et al.* (1972) and FOLMAN *et al.* (1979) reported that increasing the dietary crude protein in the ration in a hot climate increased feed intake in different breeds of cattle. AMES *et al.* (1980) confirmed that supplementation of heat stressed animals with dietary crude protein corrected the negative nitrogen balance and, consequently, increased the productive performance. Carcass weight decreased in summer groups than in NP-NE winter group (Figure 11). Serum albumin, urea-N, creatinine and SGPT were higher in HP-NE summer group and lower in NP-HE and HP-HE summer groups than in NP-NE winter group (Figure 12).

In conclusion, rabbits fed a diet containing 18.2% crude protein and 2500 kcal showed the best growth rate, feed conversion and final margin. It may be recommended to increase the dietary protein level about 2% above NRC (1977) standard and use the same NRC standards of energy in feeding of growing rabbits, under the subtrobical Egyptian conditions. Such practice, together with amelioration of heat stress conditions reported by MARAI *et al.* (Unpublished data) could be of a great economic importance in Egypt, since such practices can help in extending the breeding season for rabbit production all the year round and not to be during the months from October to May each year, as it is practiced nowadays. However, further investigations are needed to study the effects of dietary protein-energy levels on rabbits reproductive performance, under the same Egyptian conditions.

Figure 1 : Body weight, gain weight, feed intake and efficiency and final margin of New Zealand White growing rabbits, when considering the values of winter NP-NE group as 100%

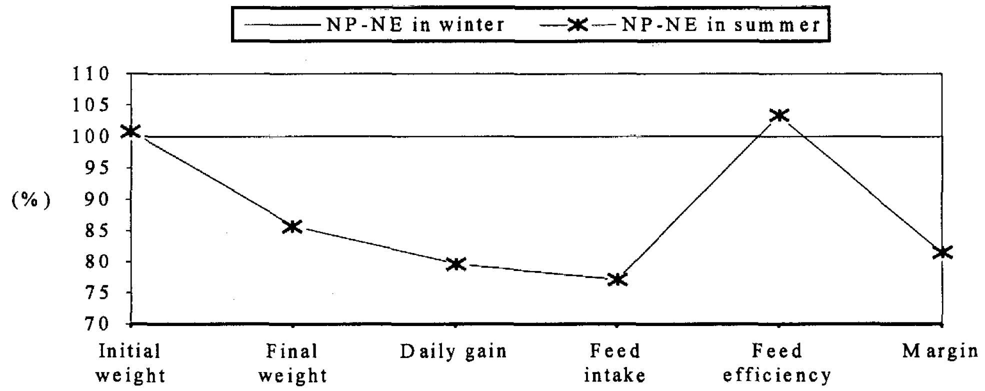


Figure 2 : Carcass and non-carcass components of New Zealand White growing rabbits, when considering the values of winter NP-NE group as 100%

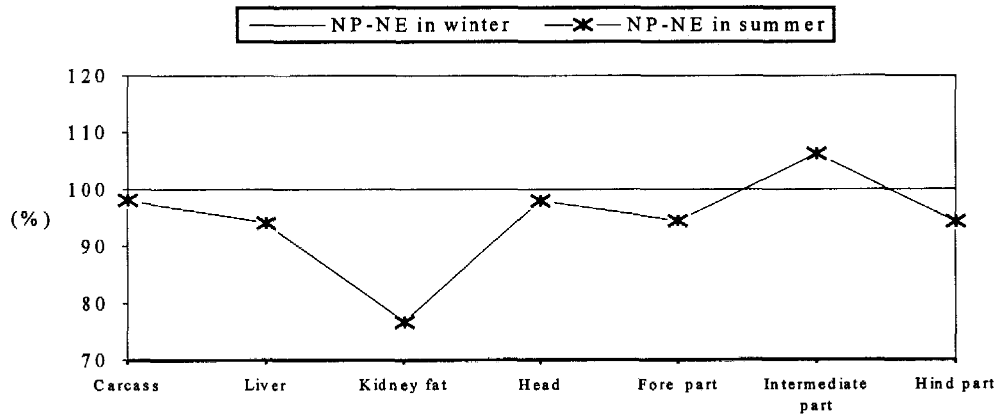


Figure 3 : Blood components of New Zealand White growing rabbits, when considering the values of winter NP-NE group as 100%

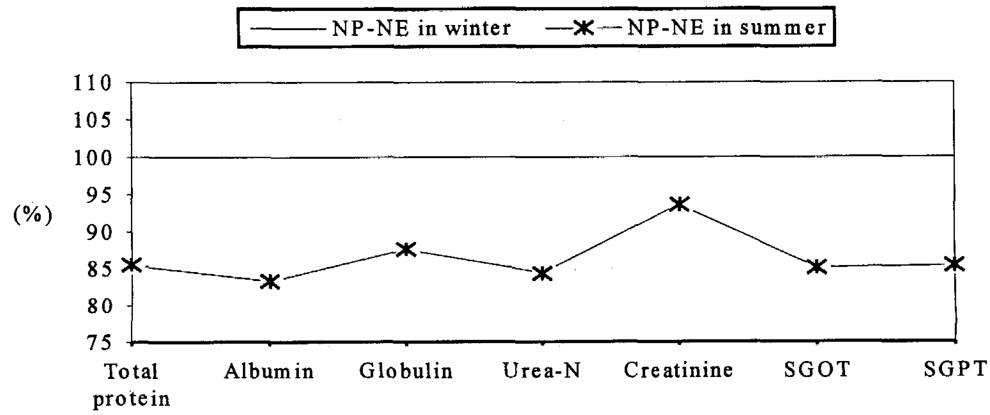


Figure 4 : Body weight, gain weight, feed intake and efficiency and final margin of New Zealand White growing rabbits fed in winter different protein-energy levels, when considering the values of winter NP-NE group as 100%.

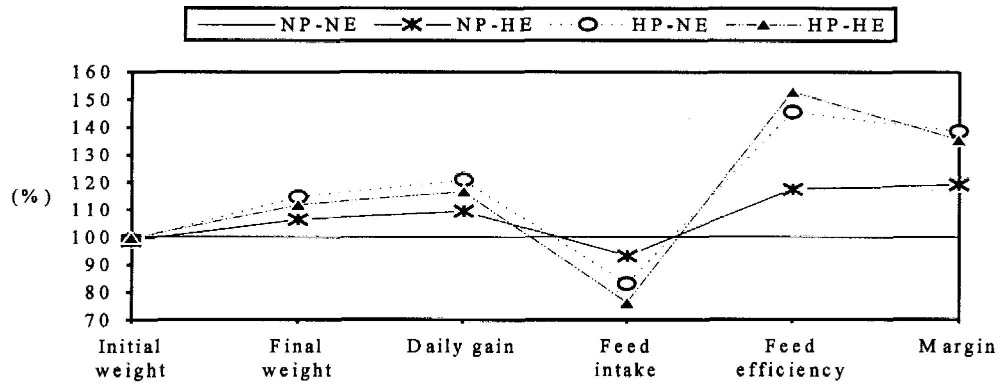


Figure 5. Body weight, gain weight, feed intake and efficiency and final margin of New Zealand White growing rabbits fed in summer different protein-energy levels, when considering the values of summer NP-NE group as 100%.

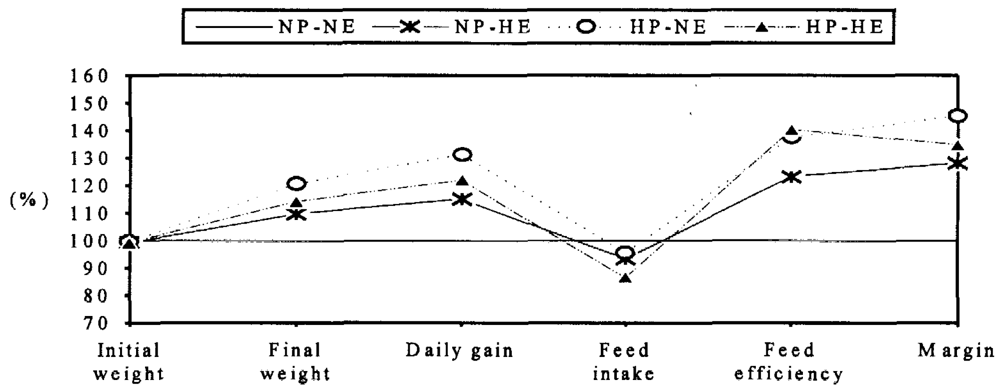


Figure 6 : Carcass and non-carcass components of New Zealand White growing rabbits fed in winter different protein-energy levels, when considering the values of winter NP-NE group as 100%

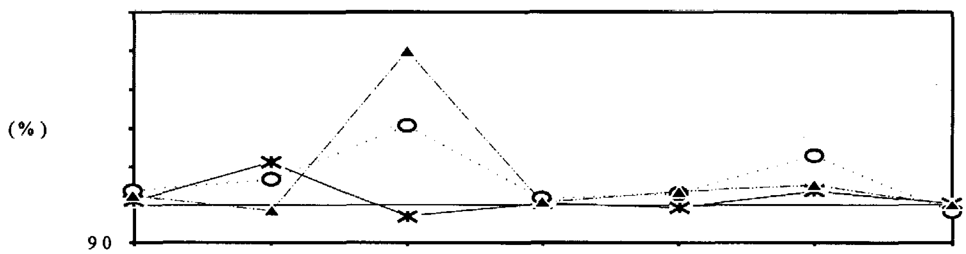


Figure 7 : Carcass and non-carcass components of New Zealand White growing rabbits fed in summer different protein-energy levels, when considering the values of summer NP-NE group as 100%

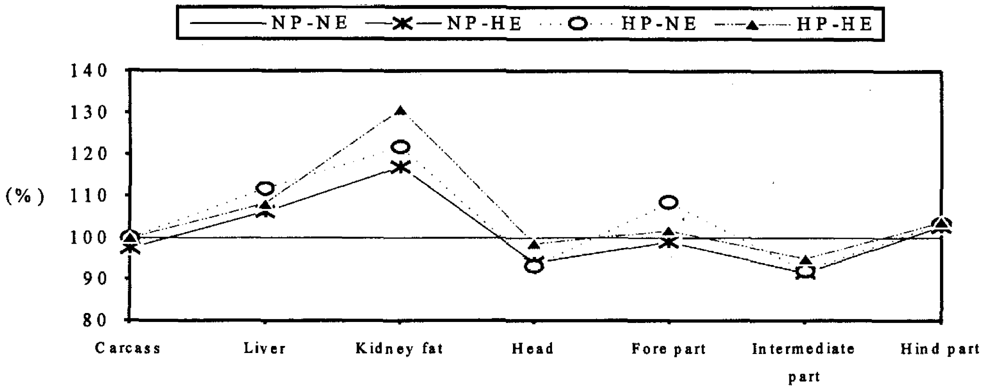


Figure 8 : Blood components of New Zealand White growing rabbits fed in winter different protein-energy levels, when considering the values of winter NP-NE group as 100%

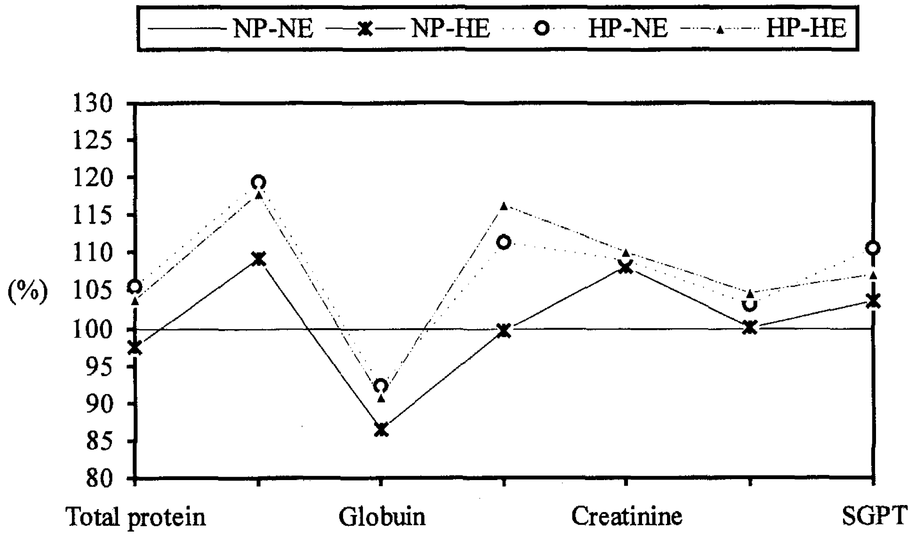


Figure 9 : Blood components of New Zealand White growing rabbits fed in summer different protein-energy levels, when considering the values of summer NP-NE group as 100%

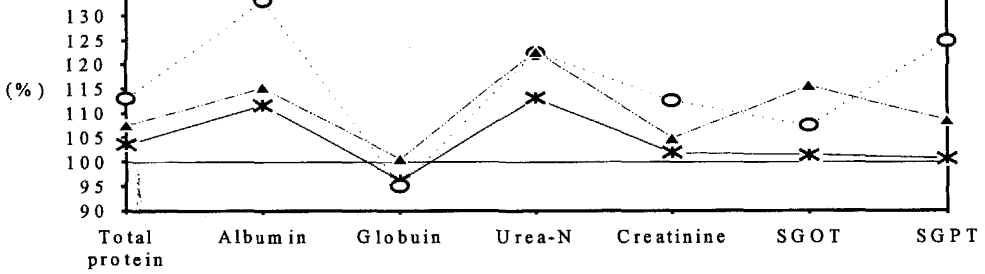


Figure 10 : Body weight, gain weight, feed intake and efficiency and final margin of New Zealand White growing rabbits fed in summer different dietary protein-energy levels, when considering the values of NP-NE winter group as 100%.

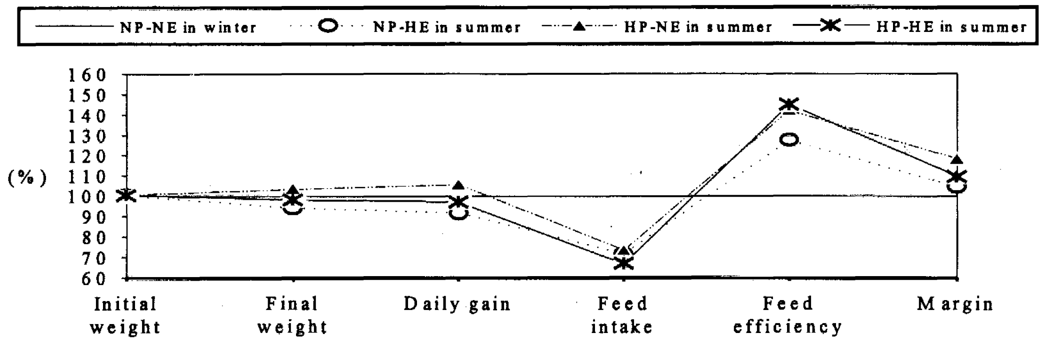


Figure 11 : Carcass and non-carcass components of New Zealand White growing rabbits fed in summer different dietary protein-energy levels, when considering the values of NP-NE winter group as 100%

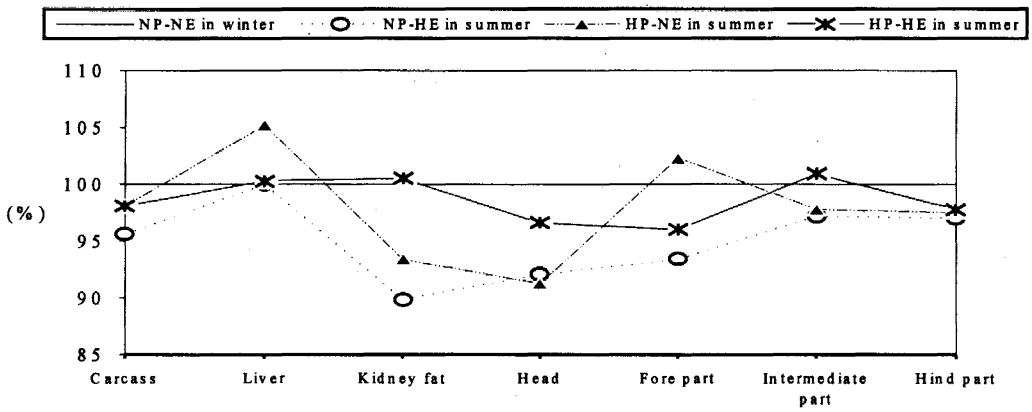
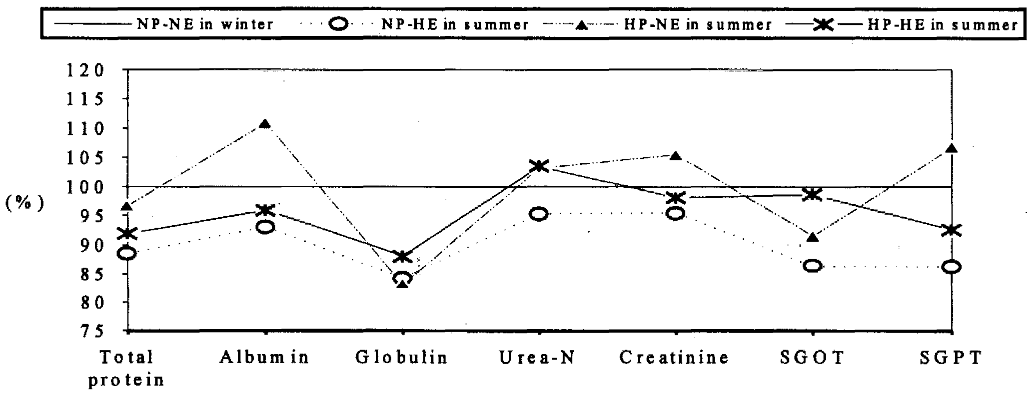


Figure 12 : Blood components of New Zealand White growing rabbits fed in summer different dietary protein-energy levels, when considering the values of NP-NE winter group as 100%



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